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ABSTRACT

Seven activities are included in this 10 day secondary school science unit in which students determine the effect that auto exhaust fumes have on the air they breathe by utilizing laboratory experiences, independent research, and in-class discussions. Rationale, objectives, and instructional strategies are provided for each activity. Following two reading activities on air pollution, air pollutants, and standards, air pollutants are identified and exhaust fumes used to determine the amount of lead, carbon monoxide, carbon dioxide, sulfur dioxide, and particulate matter in air. A list of process skills fostered in the unit, advanced teacher preparation, goals, planning guide, and evaluation suggestions are included in the introduction. (Author/JN)

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FUELING AROUND - HAZARDOUS TO YOUR HEALTH

Revised and Edited by

Hugh McDermott
Larry Scharmann

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A Basic Teaching Unit on Energy

FUELING AROUND - HAZARDOUS TO YOUR HEALTH

Original Writers

Ruth Hahn
Robert Harper

Recommended Subject: Science

ACKNOWLEDGEMENTS

The original "Basic Teaching Units on Energy" consisted of a package of 30 instructional packets contained within three volumes. The original fourteen units were written at the University of Nebraska-Lincoln, under the auspices of the Nebraska Energy Office, by Nebraska teachers participating in a three-week Faculty Development Institute sponsored by the U.S. Department of Energy (summer, 1978). The units were edited by the following individuals:

-Dr. Donald McCurdy, Professor of Science Education, University of Nebraska-Lincoln;
-Mr. Gary A. Lay, Education Coordinator, Nebraska Energy Office; and
-Dr. Robert Reeder, Science Department Chairman, East High School, Lincoln, Nebraska.

An additional eight units were written by independent authors in the summer of 1979 and the final eight units were developed as a result of a second federal grant (summer, 1980).

The present format has been achieved as a result of an evaluation conducted by the Nebraska Energy Office, February, 1981. Rather than continue to offer all 30 units as a single package, the Nebraska Energy Office determined to revise, edit, and typeset the 10-12 highest quality units and continue to offer the other units in their present format.

The editors of these revised "Basic Teaching Units" wish to thank the individual writers, original editors, and clerical staff for their contributions in creating the "Basic Teaching Units".

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TO THE INSTRUCTOR . . . .

"Fueling Around - Hazardous to Your Health" contains activities and experiments which focus on pollutants placed into the air by auto engines. Students will be able to conduct experiments which show them what particles are emitted from car engines.

Many of the experiments can be done successfully because they have some commonality, such as four experiments in which students use the exhaust fumes from autos in determining the amounts of lead carbon monoxide, carbon dioxide, sulful dioxide and other matter in the air.

In addition, since material sources continue to change periodically, the source Energy Info--A Directory of Publications and Audio-Visual Materials From the Nebraska Energy Office, contains a list of general topics available from the Nebraska Energy Office. You are encouraged to use the ordering page attached to this unit to obtain this booklet as well as other energy related materials.

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Abstract

There is virtually no way for society to avoid paying for pollution. If we do not pay for prevention, we pay in other ways. If we continue to burn gasoline in our automobiles, the resulting damage to the air we breathe could be hazardous to our health. This unit proposes to let students become actively involved in determining the effect that auto exhaust fumes have on the air they breathe by utilizing laboratory experiences, independent research, and in-class discussions. It is our hope that these exercises will create an awareness of health hazards connected with auto emissions.

Recommended Level

Grades 9-12

Time Required

10 days

Academic Area

Science

Process Skills

-analyzing
-calculating
-charting
-collecting
-designing
-estimating
-experimenting
-gathering data
-hypothesizing
-listing
-observing
-reading
-recording
-testing
-writing

Advanced Teacher Preparation

Obtain: Energy films which may be applicable to a particular activity or this unit..

Read: Energy Info - A Directory of Publications and Audio Visual Material from the Nebraska Energy Office.

Goals

When students complete this packet, they should be able to make the following generalizations about air pollution:

1. Automobiles emit substances that endanger air quality.
2. The automobile is one of the major contributors of harmful air pollutants.
3. The health of Americans is affected by auto exhaust emissions.
4. Air quality varies with the quantity of pollutants that it carries.

Student Objectives:

These are included previous to each activity.

Planning Guide

Day 1
Activity #1, "Tuning Down Auto Air Pollution"
Day 2
Activity #2, "Air Pollutants and Standards"
Day 3
Activity #2 "Identifying Air Pollutants"
Day 4
Activity #4 "Particulate Matter in the Air"
Days 5-10
Activity #5 "Measuring Sulfur Dioxide"
Activity #6 "Testing for Carbon Monoxide and Carbon Dioxide"
Activity #7 "Testing for Lead"

Evaluation Suggestions

Evaluation of this unit depends on how each activity is used and is therefore up to the individual teacher. As a suggestion, however, each student could be given a written test composed of two or three selected questions from each activity.

Instructor Information . . .

"Tuning Down Auto Air Pollution"

Rationale: Americans are reluctant to give up the use of the automobile. As a result, the Environmental Protection Agency (EPA) has been making an attempt to clean up the air by requiring auto manufacturers to make their autos more clean air efficient. This reading explains the damaging particulates released into the air and the EPA's attempt to control these emissions.

Objectives: Students will be able to read and identify air particulates emitted by autos.

Implementation: Explain what the Environmental Protection Agency is and its function. (See Supplemental Materials for resources). Hand out "Tuning Down Auto Air Pollution" and have students read and discuss it.

Debriefing: Students could research the history of the Environmental Protection Agency and what its effects have been on the quality of our air.

Name _____

Date _____

"Tuning Down Auto Air Pollution"

the automotive dilema
the auto is harmful to our health
pollution control capability

In every metropolitan area of the United States people are caught in an automotive dilemma. The comfort and convenience of the private automobile, operating on an extensive network of fine highways, has scattered urban populations all over the landscape. In the process, public transit has been severely curtailed or avoided. This excessive reliance on the automobile is poisoning the air we breathe.

Despite the energy crisis, America's geography, population patterns, and life styles dictate that the automobile will continue to play a dominant role in our transportation system for a long time. Since the damage to human health from automotive pollution is painfully real, we must do as much as we can to diminish its impact.

There are many things we can do--improved public transportation, car pooling, cleaner, more efficient automobiles, better driving habits--to cut down both on the overall use of

the automobile and to make individual cars less of a pollution problem. The purpose of this reading is to discuss one of these: theproper maintenance of automobiles so that they retain throughout their lifetime the pollution control capability that was built into them.

photochemical oxidants

Zone, peroxyacyl nitrate, formaldehyde, acrolein, nitrogen peroxide, and organic peroxides--are produced by a complex series of chemical reactions initiated when hydrocarbons and nitrogen oxide emissions from automobiles are exposed to sunlight. This type of pollution first gained attention in the 1940's as the main cause of smog in Los Angeles. Since then photochemical smog has become common in many cities.

health hazards

Photochemical oxidants can affect the lungs and eyes. They may cause respiratory irritation and even changes in lung function. They may result in eye irritation with the familiar symptoms of tears and inflamation. At certain concentrations they have been shown to impair the performances of athletes and to affect persons with asthma.

levels of pollution	Ozone, the main constituent of photochemical smog, is a severe irritant to all mucous membranes and its main health effects are on the respiratory system. It is virtually intolerable at levels of one part per million. At considerably lower concentrations (.1 to .2 ppm) -- levels which frequently occur in the summer air of many American cities--ozone, in conjunction with other photochemical oxidants, causes a variety of health effects that are aggrivated when people are active outdoors. This is the hazard that keeps the elderly, the very young, and those with respiratory problems virtually trapped indoors during air pollution alerts that can extend for many days.
carbon monoxide	Carbon monoxide is a colorless, odorless tasteless gas commonly found in our urban areas in concentrations that can be harmful to people. It is a by-product of combustion and the automobile is the largest single source of this pollutant.
carbon monoxide effects on the body	Carbon monoxide is inhaled through the lungs and enters the blood stream by combining with hemoglobin, the substance that carries oxygen

to the cells. Hemoglobin combines much more readily with carbon monoxide than with oxygen. The result is that the amount of oxygen being distributed throughout the body by the blood stream is reduced in the presence of carbon and this can have a profound impact on our health.

effects on the heart

Carbon monoxide also impairs heart function by weakening the contractions which pump blood to various parts of the body. The effect of this on a healthy person is to reduce significantly his ability to perform manual tasks, such as working, jogging, and walking. But in a patient with heart disease, who is unable to compensate for the decrease in oxygen, it can be a life-threatening situation. A person who has a heart attack is more likely to die in the presence of heavy carbon monoxide air pollution than if the attack occurred in clear air. And carbon monoxide is also harmful to persons who have lung disease, anemia, or cerebralvascular diseases.

effects on the nervous system

Carbon monoxide also affects the central nervous system at relatively low-concentrations.

Tests of automobile drivers--after exposure to carbon monoxide--show slower reaction times in response to braking signals.

achieving emission controls

In enacting the various clean air laws, the Congress left it up to the expertise of the auto manufacturers to determine how best to reduce pollutant levels. Without controls, gasoline-powered cars emit pollutants from the fuel tank, carburetor, crankcase, and engine exhaust. The manufacturers have used a variety of devices and techniques to achieve emission control.

enforcement

The U.S. Environmental Protection Agency's job is to see that the automobiles and light trucks designed and produced by the manufacturers meet the emission levels set by Congress. EPA monitors manufacturers' performance at three stages: prototype, production, and in use.

evaluating prototypes

At the prototype stage, EPA evaluates prototype models for every engine configuration in terms of their capability to meet applicable standards. In cases where more than one model

shares the same engine, EPA usually tests only the heavier model on the assumption that if the heaviest model meets the emissions levels, the lighter ones will too.

production line testing

The second testing is done on the production lines. A sample of cars is selected at random. If all pass, production continues. If one or more fails, the testing continues until a pattern can be established. If the pattern indicates a significant failure rate, production must be stopped until modifications can be made to bring vehicles into line with the legal emission levels.

the law

The law requires manufacturers to provide buyers with a warranty that vehicles are (1) designed, built, and equipped so as to conform with emission standards at the time of sale and (2) free of defects in material and workmanship which can cause them to fail to comform for a period of five years, or 50,000 miles. The third state of the Federal motor vehicle control program testing of cars in

spot checking

actual use, is meant to check for conformance to this requirement. Private firms are hired to spot-check particular models suspected of having emission problems. Onwers' lists are compiled from registration records in various cities and letters are written asking them to bring in their cars for testing. Since the test--similar to the ones made at the production line--takes more than 12 hours, owners are offered premiums such as free savings bonds, if they bring their cars in. If the cars fail even though they have been properly maintained and used, the manufacturer may be required to recall all cars of that model for basic corrective repairs of design or manufacturing.

damaged or improperly adjusted systems

The random checking of suspect models has a positive, though limited effect. But it does not address an important problem: the best designed, best made emission control systems may give poor emission-control performances if they are damaged or improperly adjusted. A car that has no emission problem in its first

months may have severe problems a year later. A number of surveys made since 1974 indicate that practically all cars which are not systematically checked and maintained, develop serious emission problems.

rising emission levels

Based on early estimates, it was projected that cars of the 1974 model year would continue to meet the Federal emission standards throughout their lives. These projections were too optimistic. By the end of their first year, the 1975 cars in regular use were exceeding acceptable levels for both carbon monoxide (CO) and hydrocarbons (HC), and careful calculations indicated that their emission levels would continue to rise in subsequent years. Cars which were not given systematic maintenance were 50 percent above the acceptable CO level at the end of the first year, and projections indicated that they would probably be emitting at twice the acceptable level by the end of the tenth year. The hydrocarbons projections, though less stark, were still ominous. However, the sharp rises in emission levels occurred only when cars were not properly maintained.

lack of maintenance

"Air Pollutants and Standards"

Rationale: The particulates in the air can have an effect on your health. Automobiles put may pollutants into the air such as lead, sulfur dioxide, nitrogen oxides and hydrocarbons. There are ways of reducing these emissions. This reading contains information about the various emissions in the air we breathe.

Objectives: Students will be able to identify various particulates in the air.

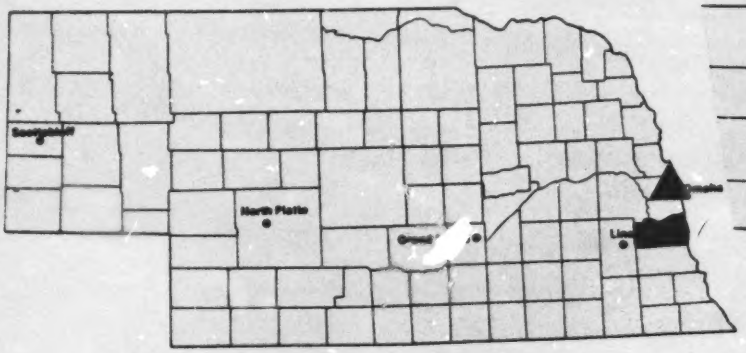
Implementation: Hand out "Air Pollutants and Standards" reading. Have students read and explain the differences between the emission elements.
Use transparency to illustrate where the greatest build-up of pollutants are located.

Debriefing: A further investigation of some of these particulates will be done through the experiments.

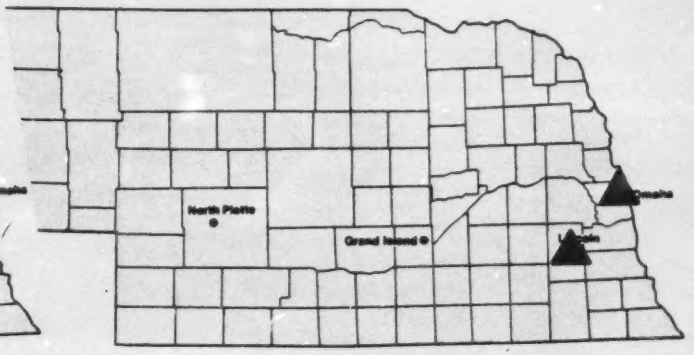
Fueling Around - Hazardous
To Your Health
Activity #2, Page 1

Name _____

Date _____



Nonattainment Areas for Total Suspended Particulates (TSP) (1980)



Nonattainment Areas for Carbon Monoxide (CO) (1980)

▲ Part of county violates primary (public health) standards.
■ Entire county violates primary standard.

total suspended particles (TSP)

Omaha and Cass County are nonattainment areas for total suspended particulates.

The term TSP refers to all the solid material floating in the air, such as dust, soot, and fly ash. Agricultural activities, construction sites, unpaved roads, grain handling, automobile exhausts, and coal conbustion are all sources of TSP. All TSP affects the respiratory system, but the smallest particles are the most harmful. In addition, toxic materials such as pesticides and lead are sometimes carried by these suspended particles.

carbon monoxide (CO)

Lincoln and Omah are nonattainment areas for carbon monoxide.

Carbon monoxide, a toxic byproduct of incomplete combustion (automobile exhausts are the major source), reduces the amount of oxygen available to lung tissues, impairs visual perception, decreases alertness, and in high concentrations, can be fatal.

The entire State of Nebraska meets the national standards for the other criteria pollutants, with the exception of Omaha, which exceeds the national standard for lead emissions. The other criteria pollutants are briefly described below.

lead

The metal lead (Pb) reaches the air primarily through the use of leaded gasoline. Other sources include lead and zinc mining and processing sites, lead recovery plants, battery manufacturing facilities, and certain industrial chemical processing factories. Lead is particularly harmful to the soft tissues of the body, the reproductive system, and the nervous system. It also can cause anemia and irreversible brain damage.

sulfur dioxide

Sulfur dioxide (SO_2) results from the combustion of sulfur-containing coal and oil, the smelting of metal ores, the refining of oil, and other industrial processes. This compound reacts readily with other atmospheric pollutants to form a group of substances called sulfates, which aggravate heart disease and such respiratory ailments as bronchitis, emphysema, and asthma. Sulfur dioxide also reacts with moisture to produce acid rain, a problem affecting the delicate ecosystems of lakes and forests.

nitrogen oxides

Nitrogen oxides (NOx) are produced by fuel combustion and come from both stationary and mobile sources. Coal- and oil-fired furnaces and automobiles are major sources. These compounds react with hydrocarbons in the presence of sunlight and produce ozone. They also cause acid rain. Nitrogen dioxide (NO_2) a form of NOx, can affect lung tissue, reduce resistance to disease, contribute to bronchitis and pneumonia, and aggravate chronic lung disorders.

ozone

Ozone is a major component of photochemical smog formed by a series of chemical reactions that

occur when hydrocarbons and nitrogen oxides are exposed to sunlight. Hydrocarbons include the fumes from any of numerous oil-delivered liquids (for example, gasoline, kerosene, diesel fuels, lacquers, and thinners). The most common sources of airborne hydrocarbons are automobiles, refineries, fuel transfer facilities, painting operations, fuel combustion in stationary sources and nature itself. Ozone, which is a severe irritant to mucous membranes, aggravates respiratory disorders, reduced lung function, and increases susceptibility to bacterial infection.

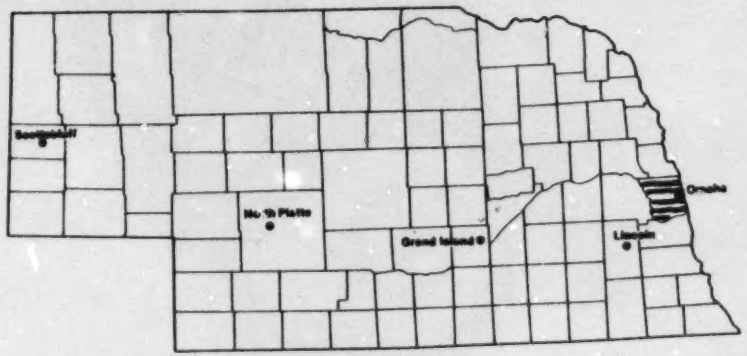
emissions

No State Implementation Plan (SIP) revisions are required in areas where monitoring indicates compliance with National Ambient Air Quality Standards (NAAQS). Existing sources, however, must meet applicable State and local regulations, and new sources may also be subject to more stringent regulations. Some new source categories must meet New Source Performance Standards. Major new sources must meet Prevention of Significant Deterioration regulations.

Of the 419 existing major point sources in Nebraska, 415 sources are in compliance with applicable emission regulations.

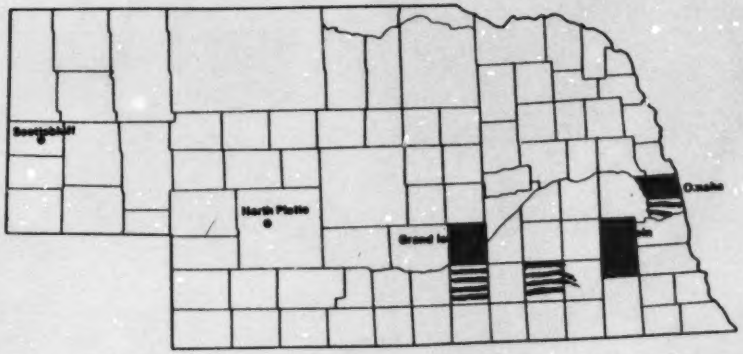
Fueling Around - Hazardous To Your Health
Activity #2

TRANSPARENCY



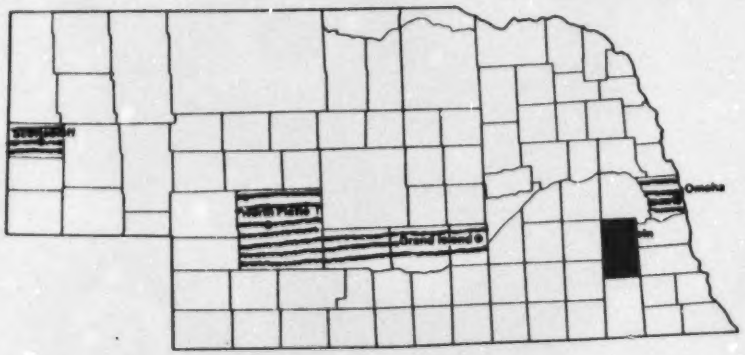
SO_2 Emissions

□ <10 ▤ 10-50 ■ 51-100 ■ >100



Hydrocarbon Emissions

□ <10 ▤ 10-20 ■ 21-50 ■ >50



CO Emissions

□ <20 ▤ 20-75 ■ 76-140 ■ >140

NO_2 Emissions

□ <5 ▤ 5-40 ■ 41-80 ■ >80

"Identifying Air Pollutants"
"Particulate Matter in the Air"
"Measuring Sulfur Dioxide"
"Testing for Carbon Monoxide and Carbon Dioxide"
"Testing for Lead"

Rationale: There are many ways to check the air for emissions. The following experiments have students check for air pollutants such as sulfur dioxide, carbon monoxide, carbon dioxide, lead, and many others.

Objectives: These are included for each experiment.

Implementation: Follow the procedural sequence provided in each experiment. Pay attention to CAUTIONS.

Debriefing: Each experiment contains a follow-up activity.

"Identifying Air Pollutants"

Concept

Substances give off harmful pollutants when burned.

Question

Would the burning of gasoline in car engines produce atmospheric particles similar to those produced in this demonstration?

Objectives

The student will be able to list the products given off into the atmosphere if sufficient heat and air are supplied to burn coal, wood, paper, and leaves.

Process Skills

-calculating
-hypothesizing
-listing
-observing
-recording
-testing

Time

Approximately one class period (one hour)

Background

The auto is the biggest polluter of all and sends millions of tons of pollutants into the atmosphere each year. Water pollution from oil spills and refinery discharge as well as land disruption from pipelines and oil wells are all a part of the automobile industry.

The automobile has introduced its own characteristic smog called the "photochemical smog". This type of smog first made its appearance in the air-locked Los Angeles basin. By definition, photochemical smog is a chemical soup that sunlight concocts from the hydro carbons and nitrogen oxides found in air exhausts.

The auto is also found responsible for two other pollutants, carbon monoxide and lead. Carbon monoxide is lethal at high concentrations and causes distress at levels of 50 to 100 parts per million (ppm). These levels are

occasionally reached in auto tunnels and closed buildings. An estimated 420,000 tons of led were released into the atmosphere in 1972 and this amount has increased yearly. Since lead accumulates in the body, we must watch carefully for long range effects.

Materials

beaker
coal
evaporating dish
ice cubes
leaves
limewater
paper
stirring rod
tripod and ring stand
wire screen
wood shavings

Caution

Many schools do not have an adequate number of hoods. It is suggested that this be a demonstration rather than allowing for active participation by students.

Procedure/Sequence

1. Weigh each sample of coal, paper, wood shavings, and leaves on a wire screen.

2. Place the wire screen on a tripod or ring stand. Set a burner underneath and burn as much of the material as possible.

3. Test for Water Vapor: (While material is burning)

   a. Place ice cubes in a beaker and hold the beaker above the fumes. If water vapor is present, it should condense on the beaker. For comparative purposes, a beaker with ice should be placed nearby.

4. Carbon Dioxide Test:

   a. Dip a glass stirring rod in the gases above the flame. Carbon dioxide will be indicated by the formation of a white precipitate.

5. Carbon and Soot Test:

   a. Place some water in an evaporating dish. (The water in the dish prevents the dish from breaking). Hold the dish in the smoke. The carbon will collect on the bottom of the evaporating dish.

Fueling Around - Hazardous To Your Health
Activity #3
Worksheet, Page 1

Name _____

Date _____

Directions: Fill out the chart provided. (It would be advisable to do this as the demonstration proceeds).

Burning Demonstration Information Chart

Material Burned	Weight of Material	Observations
Coal		
Wood		
Paper		
Dry Leaves		

Fueling Around - Hazardous
To Your Health
Activity #3
Worksheet, Page 2

Name _____

Date _____

Questions:

1) Which fuel gave off the least smoke? Most?

_____

2) Which fuel left the least ash? Most?

_____

3) Would the burning of gasoline in car engines produce atmospheric particles similar to those produced in this demonstration? How can you tell?

_____

_____

_____

"Particulate Matter in the Air"

Concept

Particulates placed in the air by auto emissions.

Question

Do car engines put out the same amount and same kind or particulates?

Objectives

The student will be able to collect auto particulates.
The student will be able to determine the number of particles that fall on ten square centimeters in a given amount of time.

Process Skills

-analyzing
-calculating
-charting
-collecting
-designing
-estimating
-gathering data
-writing

Time

Approximately one class period (one hour)

Background

The burning of fossil fuels in our nation's automobiles has added many other substances to the air besides carbon dioxide and water vapor. Five of them are known to be hazardous or injurious to plants and animals and are of the greatest concern to us.

To introduce this experiment, the instructor might want to spend some time talking about:

1) Health vs. money, in controlling air pollution from auto exhaust,
2) Drivers and maintenance, anti-pollution devices will not work if care are not properly maintained,
3) Other types of engines and alternative energy fuels.

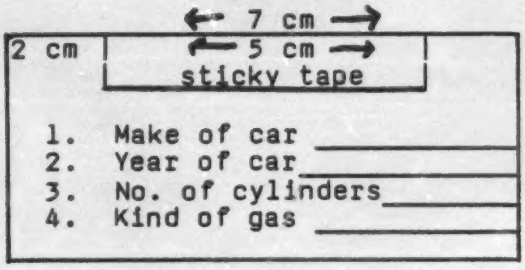
Materials

Several 6cm by 7cm pieces of cardboard
Sticky tape
dissecting microscope

Procedure/Sequence

1. Cut a 2cm by 5cm opening on a thin piece of cardboard and place a piece of wide transparent "sticky" tape on the underside of the cardboard.

2. Label the remaining portion of the cardboard as shown:



3. In the school parking lot:

   a. Choose large, small, old, and new models of cars.
   b. obtain permission of car owner
   c. Measure the diameter of the exhaust pipe before starting the motor. Be sure to keep your face away from the exhaust fumes and do not touch the exhaust pipe.
   d. Start the car's engine and collect exhaust emissions on the cardboard by holding the card directly behind the exhaust pipe.
   e. operate each engine for the same length of time (2 minutes is suggested).
   f. record the information on your information card.

4. Then in the classroom:

   a. Look at the particles under a microscope or magnifying glass. Describe the particles by
      1) estimating size of smallest and largest
      2) Shape of particles
      3) How many have sharp edges in relation to those which appear rounded and smooth
      4) How many particles are there per square cm
   b. Feel the particles. Are they soft or hard and gritty?

Fueling Around - Hazardous
To Your Health
Activity #4
Worksheet, Page 1

Name _____

Date _____

Directions: Once you have completed the "Particulate Matter in the Air" experiment, answer these questions.

Part I:

1) Which car engines appeared to release the least number of particles into the atmosphere? Why are there such differences?

_____

_____

_____

_____

_____

2. You collected particles for a total of two minutes. Estimate the number of particles per square centimeter which would be collected in one hour. Establish the class average and multiply this by the total number of cars in the U.S. to get the total number of particles thrown into the air over the U.S. for a period of one hour.

Fueling Around - Hazardous
To Your Health
Activity #4
Worksheet, Page 2

Name _____

Date _____

Part II:

1) Write a short paper listing ways in which the emissions from automobile exhausts are harmful to your health. You might want to consider different areas of the country.

"Measuring Sulfur Dioxide"

Concept

Sulfur dioxide (SO_2) is released in the air by automobiles.

Question

How can you tell if sulfur dioxide is present in auto exhaust?

Objectives

The student will be able to compare the sulfur dioxide content of automobile exhaust and relate this to the health problems caused by atmospheric SO_2.

Process Skills

-collecting car exhaust
-experimenting
-hypothesizing
-observing
-recording
-testing

Time

Approximately one class period (one hour).

Background

When fuels containing sulfur are burned, the sulfur in the fuel joins with the oxygen burned in the air to form oxides of sulfur. Fuel combustion is the major source of sulfur dioxide. Sulfur dioxide is a heavy, pungent, colorless gas that dissolves easily in water vapor to form a solution of sulfurous acid. Sulfurous acid joins slowly with the oxygen in the air to become the more corrosive, irritating mist, sulfuric acid.

Sulfur oxides can cause damage to plant, animal and human life. In humans it can irritate the upper respiratory tract and affect breathing. Sulfuric acid is responsible for the characteristic dry mouth, scratchy throat, and smarting eyes most city dwellers have experienced. Death can occur if exposed to sulfuric acid for long periods.

Materials

ice
large plastic garbage bag
permanganate; .25 g/l
rubber bands
rubber tubing
salt
solution of potassium

Procedure/Sequence

1. Collect the exhaust gases emitted from the exhaust pipe of an auto in the plastic bag.
   CAUTION: The pipe may be hot. Use gloves if necessary. Seal the bag with rubber bands and take it back to the lab.

2. Insert rubber tubing into the bag and run the tubing through a bowl of ice and salt to trap moisture. Bubble the gases into a beaker containing the potassium permanganate solution. Record the results.

Ask students to:

1. Describe the change in color of the solution.

2. Does the age and make of the car have any influence on the data?

3. What are the health hazards which can result from SO_2 in the atmosphere?

"Testing for Carbon Monoxide and Carbon Dioxide"

Concept

Carbon monoxide and carbon dioxide are released in the air by automobiles.

Question

Is there carbon monoxide and carbon dioxide in the auto exhaust?

Objectives

The student will test for carbon monoxide and carbon dioxide in the exhaust of the autos.

Process Skills

-collecting car exhaust
-experimenting
-hypothesizing
-observing
-recording
-testing

Time

Approximately one class period (one hour).

Background

Carbon Monoxide: Automobiles produce 74 percent (by weight) of the carbon monoxide found in the air. It is formed in automobiles by incomplete combustion.

Controlled laboratory experiments show that at exposures of 100 ppm most people get dizzy, develop headaches, and feel other symptoms of poisoning. A concentration of 10 ppm is not uncommon in heavy traffic. Some studies have measured 370 ppm inside vehicles in traffic jams.

Carbon monoxide poisoning occurs by reducing the mobility of oxygen in the blood, replacing the oxygen moledule in hemoglobin, and causing the hemoglobin molecules to hold on to their oxygen instead of releasing it to cells.

The result of carbon monoxide in the atmosphere is unknown. Although more than 30 million tons of CO are formed each year throughout the world, measurements have shown that the average concentration has not changed over the last 50 years.

Carbon Dioxide: Carbon dioxide is formed during complete combustion. The more complete the combustion, the more CO_2 formed. Although usually not considered an air pollutant, large quantities can have undesirable effects. In the presence of moisture, it converts to carbonic acid and erodes stone and irritates tissues.

Materials

500 ml beef blood/group
ice
large plastic garbage bag
lime water solution
rubber bands
rubber tubing
salt

Procedure/Sequence

1. Collect the exhaust from the exhaust pipe of an automobile in the plastic pipe.
   CAUTION: The pipe may be hot. Use gloves if necessary. Seal the bag with rubber bands and take it back to the lab.

2. Carefully insert rubber tubing into the bag. Run the tubing through a bowl of ice and salt to trap moisture. Bubble the fumes into the beaker of beef blood and note any color changes.

3. Bubble the exhaust into a beaker containing the limewater solution. Record the reaction that takes place.

Ask students to:

1. Describe the reaction which took place for the carbon monoxide test and for the carbon dioxide test.

2. Use a medical book or other reference to describe the chemical changes which occur in the blood from carbon monoxide poisoning.

3. Identify what health hazards can occur from high concentrations to carbon dioxide.

"Testing for Lead"

Concept

Lead is released in the air by automobiles.

Question

Is there lead in auto exhaust?

Objectives

The student will be able to test for lead and will learn that unleaded gasoline helps control lead emissions.

Process Skills

-collect car exhaust
-experimenting
-hypothesizing
-exhaust
-recording
-testing

Time

Approximately one class period (one hour).

Background

Much of the lead in the air comes from the compounds used in anti-knock agents in gasoline: tetraethyl lead and tetramethyl lead. About 70-80 percent of it is exhausted into the atmosphere in the form of small particles of lead compounds. Of the remaining 20-30 percent, about half is scavenged into the lubricating oil and half is retained in the engine and exhaust system. Lead compounds are poisonous, but it is not known precisely how damaging the lead particles from the automobile exhausts are to the environment. Lead is, however, a cumulative poison and even small amounts continuously present in drinking water could lead to death.

Materials

acid, and 10 g of chromic anhydride (CrO_3)
ice
large plastic garbage bag
rubber bands
rubber tubing
salt
solution of 20 ml water
10 ml of concentrated acetic acid

Procedure/Sequence

1. Students should choose a variety of automobiles that use regular and unleaded gasoline. Collect the exhaust emissions from the exhaust pipe of an auto in the plastic garbage bag.
   CAUTION: The pipe may be hot. Use gloves if necessary.

2. Insert rubber tubing into the bag and run the tubing through a bowl of ice and salt to trap moisture. Bubble the fumes into a beaker containing the solution of chromic anhydride and observe the results.

3. Compare the results obtained from tests with regular and unleaded gasoline.

Ask students to:

1. Write a paragraph describing the health hazards of lead in the atmosphere.

Supplemental Materials

BOOKS

Air Quality Control. National Association of Manufacturers, 1975.

Energy and Man's Environment. Jones, John, Energy and Man's Environment, Inc., 1976.

Energy Environment Source Book. Fowler, John W., National Science Teachers Association, 1975.

Environment and Man. Wagner, Richard H., W.W. Norton, W.B. Saunders Co., 1975.

Investigating Our Ecosystem. Greisel, Irma and Jensch, Peter, Houghton Mifflin Co., 1976.

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U.S. Environmental Protection Agency. Office of Public Affairs, Washington, D.C., May, 1978.

PAMPHLETS

Do You Own A Car? United States Environmental Protection Agency, January, 1978.

Nebraska's Clean Air Strategy. Nebraska Department of Environmental Control, September, 1975.

Profile of Environmental Quality-Nebraska. United States Environmental Protection Agency, Office of External Affairs, Kansas City, Missouri, September, 1980.

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